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RECOMMENDATIONS BY THE SYMPOSIUM ON HIGHER CHEMICAL AND
TECHNICAL TRAINING ADOPTED AT THE EIGHTH MENDELEYEV CONGRESS
ON 23 MARCH, 1959.

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RECOMMENDATIONS BY THE SYMPOSIUM ON HIGHER CHEMICAL AND
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Following is the translation of an article in Problemy Vysshego Khim i Tekhnologii Obrasovaniya (Problems in Higher Chemical and Technical Training). Moscow, 1959, pages 32-417

Having heard and discussed a report by Comrade Torocheshnikov on "Measures Toward Better Training of Specialists for Chemical Industries," the symposium points to the resolutions adopted at the Twenty-first Congress of CPSU and the May Plenum of the Central Committee, CPSU, as being of major importance in this connection.

The historical decisions adopted at the Twenty-first Congress of our Party envision a more rapid development of chemical industries, with broad mechanization and automation applied to the technological processes. The decisions of the May Plenum, CC, CPSU ask for better training of specialists going into the chemical and the associated machine-building industries, as well as specialists on the automation of technological processes. In addition, they ask for a widely developed program of theoretical studies and practical research to be carried on by the personnel of higher educational institutions in the vast field of chemistry and chemical technology.

During the period of 1959 through 1965 our universities and colleges must train over 70,000 specialists in theoretical and technological chemistry, machine building for chemical industries, and the automation of technological processes.

An Act passed by the Supreme Council of the USSR requested that our schools be "brought closer to life," as a step "furthering the people's education in the Soviet Union." To implement the basic provisions of this Act, our colleges and universities must in the shortest possible time do away with the existing shortcomings in the training of specialists, which to some extent remains dissociated from the practical needs of the moment.

With a view to a more effective functioning of the chemical and technical colleges, the symposium recommends the following program implementing the above Act. The proposed measures are to be developed and carried out by the higher educational institutions, the various ministries and governmental departments, the (administrative) districts

Councils of National Economy, and the local branches of Mendeleyev All-Union Chemical Society.

I. The symposium deems it necessary to make the following recommendations to colleges and universities:

1. The training of specialists should follow the educational patterns to be elaborated further by the Ministry of Higher Education, with active participation by the higher educational institutions and the chemical profession, namely:

a) In the institutes preparing mechanical engineers for chemical, textile and light industries, as well as for building refrigerating and chemical equipment, the students should be trained during the first two years without leaving their jobs in the industry.

For senior students the plan envisages a program of practical training.

b) The training of students specializing in certain food-processing industries, for instance, in the sugar industry, must follow seasonal schedules adapted to conditions peculiar to the given industry.

c) Specialization in the various fields of technological chemistry and automation of industrial processes provides for the student's training without discontinuance of his factory job during the first year and during one of the senior terms.

d) University students majoring in "chemical science" are requested from the outset to take up a series of complicated theoretical subjects, besides being assigned a great deal of laboratory work. The same requirements exist in certain fields of technological chemistry involving newly developed techniques. During the first 2-3 years of training, such students could be allowed to leave their factory jobs, while during senior terms they would receive regular one-year appointments working directly in the industry, or in research institutes and design offices.

2. Proper attention should be paid to the training of highly qualified technologists and research engineers specializing in the technology of monomers, polymers and polymer processing, application of atomic energy in chemical technology, as well as designers of equipment for chemical industry and specialists in the automation of technological processes.

3. Introduce into the curricula of technological institutes and universities a presentation of scientific material dealing with the use of hard radiations, ultrasonic oscillations and high frequency currents.

4. Bearing in mind that a considerable number of the chemical engineers will be working at central factory laboratories, experimental stations, designing offices, etc., students' training should emphasize elements of research work in all the courses of instruction.

5. The study of general scientific disciplines (social, economics, mathematical mechanics, physical chemistry) should be intensified, while combined judiciously with the general and specialized engineering subjects.

6. Research engineers, selected on the basis of thorough evalua-

tion of the student by the teaching personnel in the course of 3-4 years, should be trained individually, taking into consideration the specific nature of the school as well as of the industrial establishment of scientific institutions to which the specialist will be assigned.

7. The training of mechanical engineers for the chemical industry, besides control and maintenance men, should turn out also research specialists and designers of machinery and laboratory equipment.

8. Higher quality of training should be attained in preparing chemical engineers and technologists specializing in automatic self-regulating equipment used in chemical industries and in chemical stability of materials.

9. The universities and technological institutes should take the necessary steps toward training a sufficient number of specialists in organic analysis urgently needed by national economy.

10. The existing curricula should be revised without delay, to eliminate duplications and redistribute the material treated in the various courses.

The following changes, in particular, should be considered advisable:

a) The problems involving the structure of matter, chemical thermodynamics and chemical kinetics should be confined to the course of physical chemistry.

b) The course of analytical chemistry should be expanded to include chapters on dissociation of weak electrolytes and the modern theory of acids and bases, measured conductometrically.

c) The course of organic chemistry should be revised to strengthen its theoretical foundations. At the same time laboratory hours should be increased, to help the students develop the necessary skills in experimental work and learn the modern chemical and physico-chemical methods of synthesizing and investigating organic compounds.

d) In defining more closely the future curricula, some consideration should be given to the resolution adopted at the All-Union conference on chromatography, namely, that problems relating to the chromatographic method be discussed in various courses in chemistry.

e) Intensified training should be given in physico-chemical methods applied to analysis and in general analytical procedures used in technology. Study of technical analysis should also be a part of practical industrial work assigned to students.

With respect to engineering sciences the following steps appear to be advisable:

a) The section on industrial electronics, as part of the course in electrical engineering, should be considerably expanded, eliminating some of the material incorporated in the existing program.

b) The course in tensile strength of materials should include information on the mechanical properties of plastics and the course in machine parts, information on plastic components now used in the construction of chemical machinery and laboratory equipment. Further additional information should cover the basic elements in designing auto-

matic controls for industrial processes.

c) The program for the course in theoretical mechanics should be worked out following the recommendations contained in instructions No. 784 issued by the Minister of Higher Education on 26 July, 1958.

d) For students of technological schools, the scope of training in the fundamentals of the automation of industrial processes should be clearly defined, and coordinated with the special subjects taught in the given field.

II. The following measures toward a better organization of higher chemical and technical training in the Soviet Union are requested by the symposium, to be instituted by the Ministry of Higher Education, USSR:

1. To expand the network of night schools and correspondence schools, with particular emphasis on intensifying the systematic work done in the field of nighttime instruction and tuition by correspondence. Students attending night classes at colleges and universities, or receiving instruction by correspondence from the special departments of these educational institutions, should be granted certain privileges (shorter working day, extended leaves of absence for laboratory work and quizzes, transfer to regular personal-attendance classes during senior terms, etc.).

2. To improve the existing conditions with respect to completion of graduation theses by the students of technological institutes and university students (the time needed to complete the thesis could be extended, the laboratories better equipped, etc.).

3. To organize teachers' schools at universities associated with the departments of chemistry, with some modifications of the existing curriculum for students specializing in chemistry, which provides for the training of secondary school teachers.

4. To improve the enrollment plan for students seeking admission to higher educational institutions for specialized training.

5. Along with the general broad and thorough university training of research chemists in the basic branches of chemical science, to develop a training pattern for research men specializing in such borderland sciences as physical chemistry, biochemistry, geochemistry, etc.

6. To train technologists and research men specializing in silicon chemistry and pure chemical reactions.

7. To organize at the institutes of technology the training of technologists, research engineers and mechanical engineers specializing in radiation chemistry, the use of isotopes, in the fitting out of installations for chemical radiation processes, as well as in corrosion of chemical equipment and in the corrosion-resistant synthetic materials.

8. To engage a larger number of specialists from industry, without taking them away from their jobs, to teach applied sciences and special faculty courses, both intramurally, at universities, and to students working in a plant or given a practical industrial assignment.

9. With a view to training highly qualified specialists for central factory laboratories, equipped with thorough engineering knowledge

coupled with high skill in experimentation, five to ten percent of students graduating every year from the higher technical schools and institutes of technology should be kept at school for a term not exceeding two years, to receive advanced training for subsequent work in the specialized scientific departments and research laboratories as laboratory assistants, senior laboratory assistants and junior scientific workers. To this end the necessary number of salaried positions should be established, and special funds allotted, by the higher technical schools.

10. Considering the exceptional importance of chemistry and chemical technology for technical advancement in the Soviet Union, it is advisable:

- a) To institute entrance examinations in chemistry at all higher educational institutions where chemical subjects are taught.
- b) To assign 160-180 hours to the course in general chemistry.
- c) To make a recommendation to colleges and universities that the course in physics should precede the course in general chemistry.
- d) To establish a position of assistant lecturer for each chair of chemical sciences.
- e) To revise the programs of the various courses in chemistry.
- f) To produce a number of textbooks and educational aids in chemical subjects taught at higher schools not specializing in chemistry (including special equipment for lecture demonstrations).
- g) To arrange regular conferences of the pedagogues teaching chemical subjects, at which they could exchange experiences and learn of the latest advances in chemical science and technology.
- h) To expand the courses in physical and colloidal chemistry for the needs of agriculture, mining and building industries, medical science, and other specialized fields.
- i) To institute faculty courses in the latest advances in chemistry (synthetic and semiconductor materials, corrosion of metals, new alloys, etc.).
- j) To ensure better supply of laboratory apparatuses and equipment, chemical ware and reagents, for the various chairs of chemistry.
- k) To organize centralized manufacture of visual aids for the teaching of chemical sciences (models and mockups, tables and charts, special equipment, etc.) for lecture demonstrations, with which all higher educational institutions must be regularly supplied.

11. The development of new branches of chemical industry and introduction of automatic regulation and controls create an urgent need for training research chemists equipped with a thorough knowledge of many subdivisions of inorganic, organic, physical and colloidal chemistry, physics and mathematics - men capable of experimental and theoretical work on the level of modern requirements.

The training of such specialists should become the task of universities and those technological schools which turn out research engineers possessing the high skills necessary for solving the practical problems of today and finding ways of bringing new technological processes into existence.

For effective realization of such training, the following steps are necessary:

- a) To encourage the students in developing self-reliance and an interest in scientific research, course theses should be assigned to them in every term, allowing sufficient time for this work in the curriculum.
- b) Graduation theses should be in the nature of original scientific studies, incorporated into research projects carried out by the teaching personnel of the chair.
- c) The activities of students' scientific societies should be encouraged in every way.

12. The training of scientific workers can be achieved most effectively through post-graduate research assignments in physical, colloidal, organic and inorganic chemistry, insofar as the scientific aspects of these disciplines are related to the problems of technology. Such research can be done also in the various departments of technological sciences, working creatively toward a solution of current industrial problems, with the aid of theoretical and experimental resources accumulated by the physical chemistry and physics of today.

To attain a higher level of efficiency in the realization of this training program, certain other steps seem desirable, to wit:

- a) Alongside of gifted individuals with some previous experience, the enrolment for postgraduate research should include also a few university and technological school graduates who have shown a distinct aptitude for scientific work, a flair for theoretical study, and who have been active in the various groups of the students' scientific society.
- b) Not later than six months following enrolment, the post-graduate research students must be given an assignment in experimental work related to a thesis, as part of a study carried on by his department. The significance of his theme in relation to the general problem must be explained to him in detail.
- c) The requirements for entrance examinations must be raised considerably, and the same applies to post-graduate examinations in the applicant's special subject. The essential purpose of such tests is to detect in the student a capacity for critical evaluation of literature material, as well as for analytical and synthetic reasoning in experimentation and in examining the results.
- d) Prior to taking examinations for post-graduate enrolment it would seem advisable for the applicant to select the particular subdivisions of the subject related to his future work in research or in competitive studies for a degree, since these are the branches of science with which he must be thoroughly conversant as a specialist.
- e) At the end of the first year of post-graduate work the appointees should undergo rigorous evaluation, with subsequent dismissal of the students who have not shown sufficient aptitude for experimentation and theoretical studies.
- f) The requirements with respect to the knowledge of foreign languages should be raised considerably.

3) Post-graduate students working on a dissertation while on the

job must be assured of the necessary facilities for effective experimentation and theoretical elaboration of the thesis. Such conditions include a working place, the needed equipment, and the possibility of regular contact with the supervising instructor.

13. To raise the professional skills of specialists engaged in the various branches of national economy, special departments should be instituted at some of the higher educational institutions where advanced instruction could be provided for engineers working in the basic industries. A higher qualification level should be sought by every engineer after every 3-5 years of working in his special field.

The following training arrangements would seem to answer the purpose:

a) With a leave from the factory job for a training period of three months.

b) Correspondence courses with a two-year training period. The trainee is summoned to the Institute for a two-month period, during which time he will perform laboratory work and will study the more advanced techniques used in the industry.

B) Short term seminars, up to two weeks, for getting acquainted with the latest advances in science and technology at leading industrial establishments.

III. The symposium deems it necessary to call the attention of Ministries of Education of the Union Republics to the importance of raising the quality of school instruction in mathematics, chemistry, physics and foreign languages. These subjects are of particular significance for secondary school graduates entering institutes of technology as well as university departments of chemistry or technology.

The symposium wishes to make the following recommendations to Ministries of Education of the Union Republics:

1. To engage a larger number of workers in chemical industries, institutes and laboratories to teach physics and chemistry in schools.
2. Instruction in foreign languages should begin at an earlier age (from the second or third school year).

Considering that the availability of scientific chemical literature and textbooks is enormously important for further technical advancement of the country, the symposium has given much thought to the publishing of textbooks and scientific material. It should be noted, in particular, that the general situation with regard to chemical publications does not meet present needs in the progress of scientific work in chemistry and chemical technology, nor is it satisfactory for the training of specialists in compliance with the decisions of the Party and the Government. For the majority of chemical and technological subjects, the published textbooks are not always adapted to the specific teaching requirements at the higher schools of various types. In some subjects (colloidal chemistry, structure of matter, and a number of highly specialized sciences) no textbooks answering modern requirements are available at present.

To improve the situation with regard to the publication of sci-

tific chemical literature and textbooks, the symposium has acknowledged the following to be necessary:

1. Textbooks in the basic sciences should be published simultaneously, in accordance with the scope of the course, the type of school and the method of instruction. The size of the textbook must be determined not only by the number of hours allowed for the course but also by considerations of more effective instruction.

2. The processing of a textbook should be simplified. With the present procedure it may take 2-3 years before the manuscript will come off the press. As a result, the textbook is often dated before publication.

3. Measures must be taken to improve the work of Knigotorg [the book-selling agency] in distributing educational and scientific chemical literature in remote districts, to meet the needs of scientific, engineering and technical personnel, as well as of the students.

4. The publication of scientific and technical monographs and symposiums should be expanded (including translated works).

5. Textbooks and educational aids published in limited editions by colleges and universities should be produced on a wider scale at reduced prices, after the necessary ways and means have been found for making their publication less costly.

6. Textbooks adapted to the special needs of the higher schools of chemistry should be produced on the subjects of mathematics, physics, applied mechanics and foreign languages.

7. While acknowledging the valuable initiative of the Ministry of Higher Education in starting the publication of chemical journals, it seems advisable to request that the journals be increased in volume.

8. Publication of a journal should be started devoted to higher education in chemistry. The journal should serve the purpose of improving methods of instruction, by publication reports reviewing the latest advances in science and technology, as well as material on the methods of presentation of individual chemical problems, on methods of experimentation, on lecture demonstrations, etc. The Ministry of Higher Education, USSR, should be requested to take the necessary steps toward the publication of such a journal.

9. The Presidium of the Academy of Sciences, USSR, as well as the State Commission for Science and Technology affiliated with the Council of Ministers, USSR, must be credited with a major effort in publishing a Chemical Abstracts Journal. A presentation should be submitted to both organizations, the Academy and the Commission, requesting that the journal be published in separate issues covering the various fields of chemistry.

At the same time, it must be admitted that the much-delayed publication of subject indexes for the journal threatens to detract essentially from the value of the work achieved.

10. The Ministry of Higher Education, USSR, is to be credited also with initiating the publication of a comprehensive Soviet reference book containing physico-chemical and technological values. The Ministry

should be asked to expedite the publication.

At the same time, there exists a need for reference books covering the various branches of chemistry and chemical technology (large and small editions) to be used by scientists, teachers and engineers, as well as by the students. The ready availability of such reference books will help training the students in the use of tabulated data, which is most essential where practical skills for independent work are to be developed.

Apart from carrying on this publication program, it is necessary, in the nearest future, to publish in translation, or by photo-offset, some of the better foreign reference books covering the various branches of chemistry, physical chemistry, chemical thermodynamics and chemical technology. It is important, in particular, to complete the publication of Landolt's tables.

V. The symposium considers it desirable that uniformity of scientific terminology, in the field of chemistry, as well as of the nomenclature of chemical compounds, be achieved presently. To this end, the Standardization Board, Council of Ministers, USSR, as well as the Commission on Technical Terminology and the Commission on Nomenclature of Chemical Compounds, Ac. Sci., USSR, must be asked to furnish regular information, in chemical journals, on newly adopted standards and recent decisions concerning the nomenclature of compounds. Innovations of particular importance should be brought up for a broad preliminary discussions by the chemical profession.

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